

Raytheon

Generalized Automated Maintenance Environment




Objectives



- Overview of gAME and What Has Been Accomplished
- Overview of How it Works
- Additional Capabilities
 - Modify the Maintenance Plan
 - Offline Toolkit
- Conclusion

Raytheon and AME



- Successfully Responded to a BAA from ONR and PMA-265
 - Provide a COTS IDE to support the F/A-18 AME
 - Solutions must be open architecture and generalized in applicability.
 - Not weapon system or aircraft platform specific
- Formed a team of vendors providing world class software solutions, resulting in the generalized Automated Maintenance Environment (gAME)
- F/A-18 E/F OPEVAL chose core asset management component as ECAMS Replacement
 - Selected to use gAME architecture approach as risk mitigation to OOMA support of OPEVAL
 - Referred to as SuperHornet AME (sAME)



Objective: generalized Automated Maintenance Environment (gAME)

- To provide customers an open architecture infrastructure to provide for integrating COTS software and legacy solutions.
- Use existing communications systems to provide all supportability requirements and improve the readiness of our weapons & defense systems.
- The generalized AME will further improve the effectiveness of the maintainers by providing electronic training and assistance while providing “real-time” support for battle damage assessment in times of conflict.



Key Features

- generalized AME team provides an integrating infrastructure
 - Open architecture environment
 - Make full use of legacy investments
 - Easily integrates into existing Information Systems
 - Mission Planning
 - Training
 - Depot Repair and CLS
 - Parts Distribution
 - Compliant with a DoD related initiatives
- Provides digital supportability information increasing the timeliness and accuracy of data.



Key Features (con't)

- **Totally COTS based**
 - Provides transparent insertion of new latest computer technology with little or no cost to the customer.
 - Customer costs are based on scaleable use fee
 - Can be implemented by platform, or by function
- **Provides:**
 - Component Base Tracking
 - Network and Satellite connectivity
 - Configuration/Asset Management
 - Logistics Planning Tools
 - Prognostics/Diagnostics
 - Training
 - Reporting
 - Depot Activities
 - Base Supply and Parts Distribution



What's Been Accomplished?

- Built an integrated team of domain experts.
- Provided Core Configuration/Asset Management module to support F/A-18 E/F OPEVAL (sAME)
 - Interfaced with existing functional technology investments.
 - | IETM's
 - | Pilot Debrief
 - | Data Stripping Unit
 - | Life Usage Index (LUI) Calculator
 - | Engine Diagnostics
 - | Help Request Document (HRD)
 - Developed LAN/WAN architecture for global deployment.



Benefits to F/A-18

- Resolves 10 of 18 Readiness Issues
- Resolved ECAMS Y2K Problem
- Compliments legacy NALCOMIS and other systems with COTS solutions
- Provides Point-Of-Maintenance (POM) entry of data that is integrated with the next level of maintenance.
 - Data collected at O-Level is transmitted to the I-Level.
 - Data collected at I-Level is transmitted to the Depot, and/or OEM.
 - All fleet-wide data is made available at the up-line repositories.
- Provides Annual Cost Savings
 - Multiple legacy systems can be terminated.
 - Eight percent labor cost reduction.
 - Five percent material cost reduction by improved asset management.



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Overview of How it Works



Modules at O-Level

- Download/Data Stripping
- SAFE File Generator
- LUI Calculator
- Applications/Session Manager
- Debrief
- I ETMs/HRD(TMDR)
- Configuration/Asset Management
- Engine Diagnostics

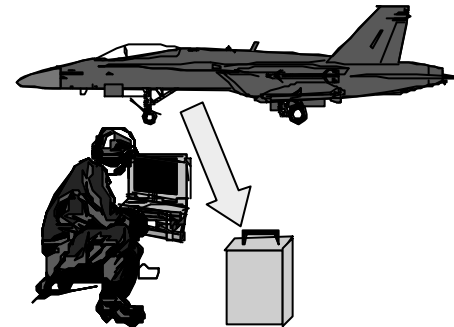
A Flight→Usage Accrual & Debrief

■ What Occurs:

- An aircraft flies
- The MU is brought in and stripped by the Pilot. The data is copied to ADFs on the AME PC
- The Debrief module is launched at the end of the download
- A pilot validates/adds any faults using the Data Stripping and Debrief modules
- In the background, usage is extracted from the MU data and applied to the aircraft records in Configuration and Asset Management Database

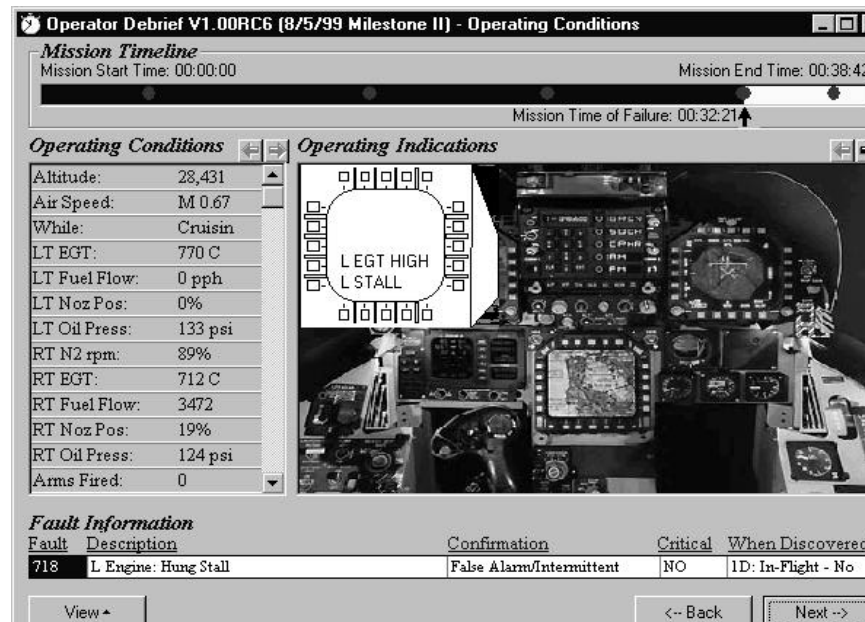
■ gAME modules involved:

- | Applications/Session Manager
- | Data Stripping
- | F414 LUI Calculator
- | Debrief
- | Maintenix/OOMA



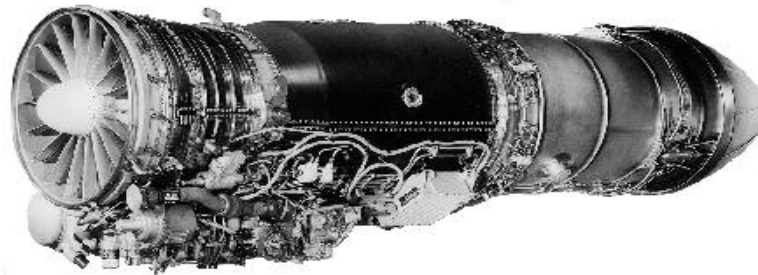
Debrief Logs any Additional Discrepancies

- The pilot reviews the faults identified by the expert system and adds any other discrepancies
- Suggested maintenance tasks are passed to Maintenix/OOMA



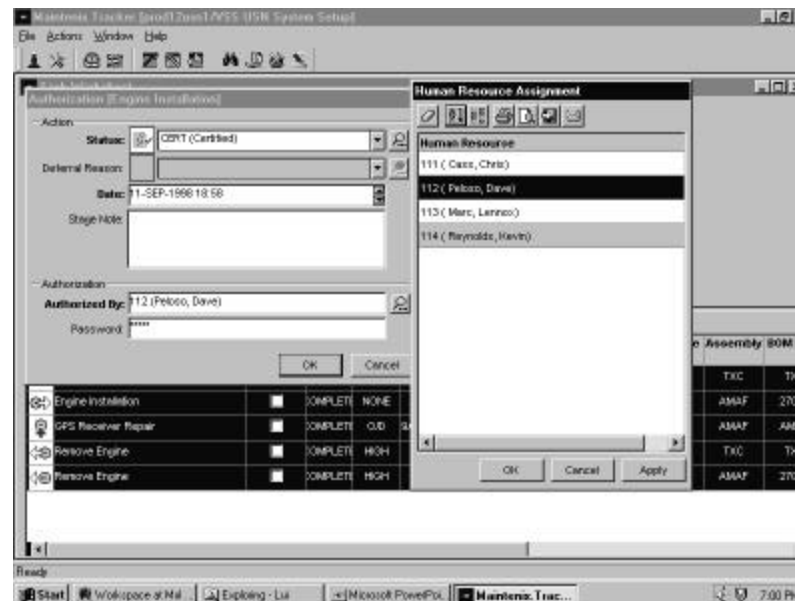
Background Processing of Aircraft Data

- Engine LUIs are extracted from the aircraft data and applied to Maintenix/OOMA
- SAFE files are created with the structural data
- The Engine trending and diagnostics data set is updated with new data



NAVFLIR Completion

- The pilot completes a NAVFLIR in NALCOMIS
- A maintainer enters the landing data in Data Stripping to complete the SAFE file and provide landings as usage data to Maintenix/OOMA



Maintenance Scheduling and Execution

■ What Occurs:

- A maintenance action initiated by Debrief
- A maintenance action initiated by engine LUI data reaching the life limit
- The maintenance “due list” for the aircraft automatically updated to reflect the new maintenance actions
- An engine removal and transfer to IMA for overhaul
- The aircraft left in an operational state

■ gAME modules involved:

- Maintenix/OOMA
- Applications/Session Manager
- IETMs



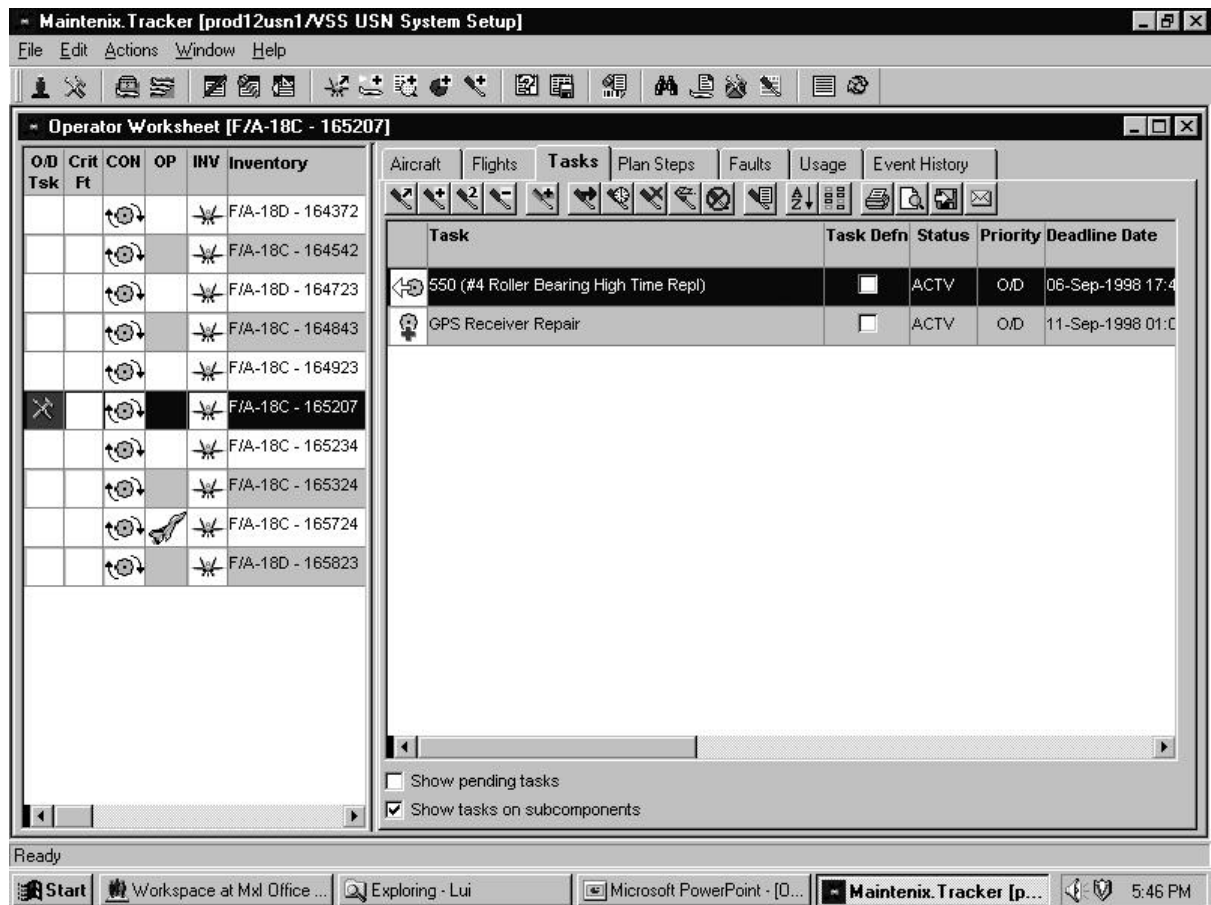
Auto Scheduling

■ Recall

- The Debrief expert system analysis suggested a maintenance task
- The Data Stripping process extracted engine usage (LUI s) from the aircraft data and applied it to the engine records in Maintenix/OOMA.
- The Maintenix/OOMA Operator Status Board, as Maintenance Control's "White Board", is automatically updated to show an overdue task for the subject aircraft.

Maintenance Alerted to Aircraft Caution

- The aircraft is shown with overdue tasks
- The maintenance tasks are shown
 - Debrief task is to repair GPS receiver
 - the LUI increase has caused an engine turbine to go 'high-time', requiring an engine removal



Identify Maintenance Tasks

- Maintenix/OOMA shows all upcoming work for the squadron to Maintenance Control
 - Work can be sorted to facilitate planning
- Maintenance Control initiates MAFs NALCOMIS based on the Maintenix tasks

Maintenix.Tracker [prod12usn1/VSS USN System Setup]

File Actions Window Help

Task Worksheet

Retrieve:

Row Limit: 1000

Search By:

Inventory:

Root Inventory:

Assembly:

BOM:

Assigned To:

Plan Step:

Task:

Task Class:

Work:

Labour Skill:

Work Type:

HR:

Work Dept:

☐ Historical Tasks

Status: ACTV (Active)

Task	Task Defn	Status	Priority	Deadline Date	Main Usage Until Deadline	Usage Until Deadline	Assembly	BOM
215 (Stg 1 Fan Blade Set High-Time Repl)	<input checked="" type="checkbox"/>	ACTV	LOW	10/21/98 18:36:40	40.0hour(AFH)	40.0LUI(ELCF)	TXC	274
GPS Receiver Repair	<input type="checkbox"/>	ACTV	O/D	9/11/98 01:00:00	-0.7hour(AFH)	-0.7day(CDY)	AMAF	AA
21 Day Inspection	<input type="checkbox"/>	ACTV	NONE	9/15/98 00:00:00	3.2hour(AFH)	3.2day(CDY)	AMAG	AM
030000C (30 Hour Special Engine Insp)	<input checked="" type="checkbox"/>	ACTV	LOW	10/11/98 18:36:40	30.0hour(AFH)	30.0hour(AFH)	AMAF	27
550 (#4 Roller Bearing High Time Repl)	<input type="checkbox"/>	ACTV	O/D	9/6/98 18:36:40	-5.0hour(AFH)	-5.0hour(EOT)	TXC	27
550 (#4 Roller Bearing High Time Repl)	<input type="checkbox"/>	ACTV	O/D	9/6/98 18:36:40	-5.0hour(AFH)	-5.0hour(EOT)	TXC	274
Remove Engine	<input type="checkbox"/>	ACTV	HIGH				AMAF	27

9 Rows Retrieved

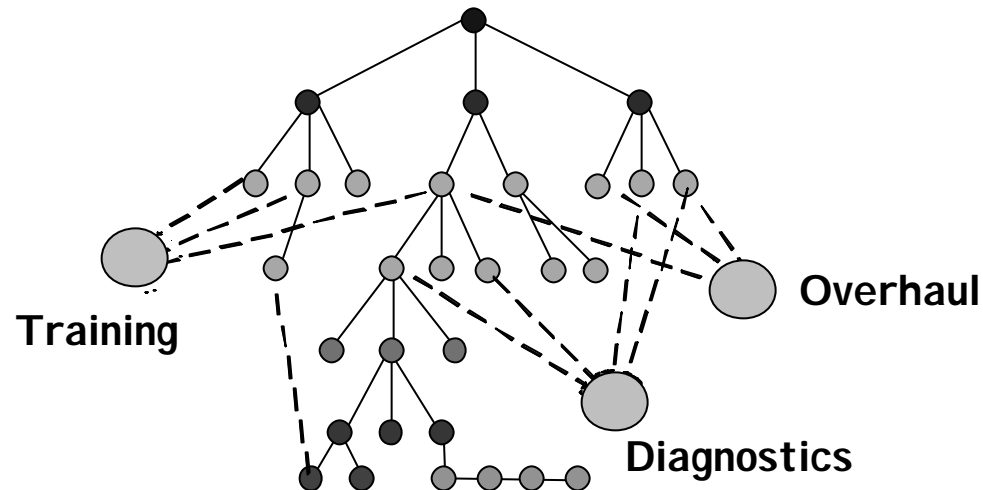
Start Workspace at Mxl ... Exploring - Lui Microsoft PowerPoi... **Maintenix. Trac...** 6:41 PM

Download I ETMS to PEDD

- Session Manager gets a list of maintenance tasks from Maintenix/OOMA
- This information is used to download I ETMS links to the PEDD

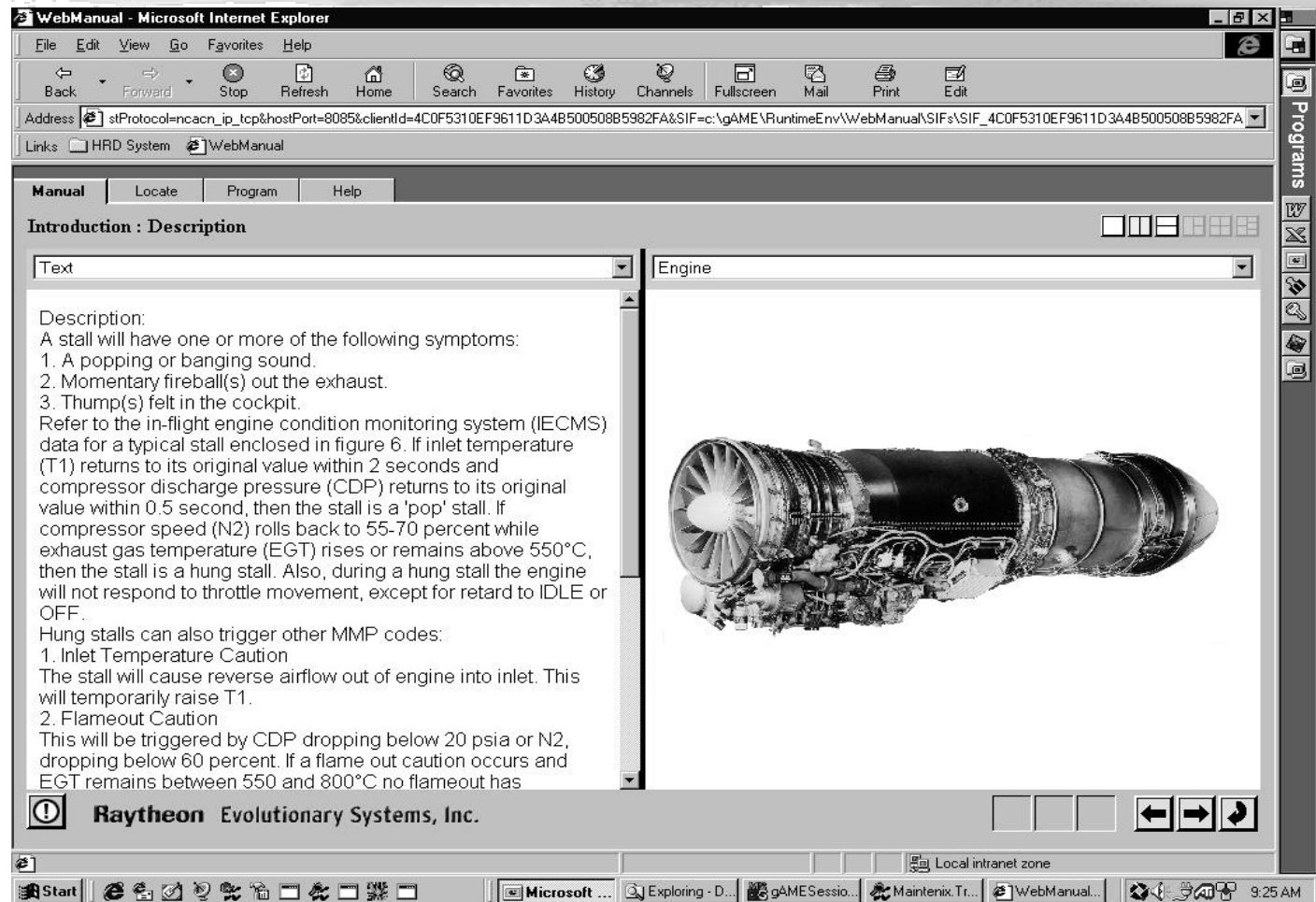
AIMSS™ Class 5

- database
- hierarchical
- non-redundant
- relational links
- context filters



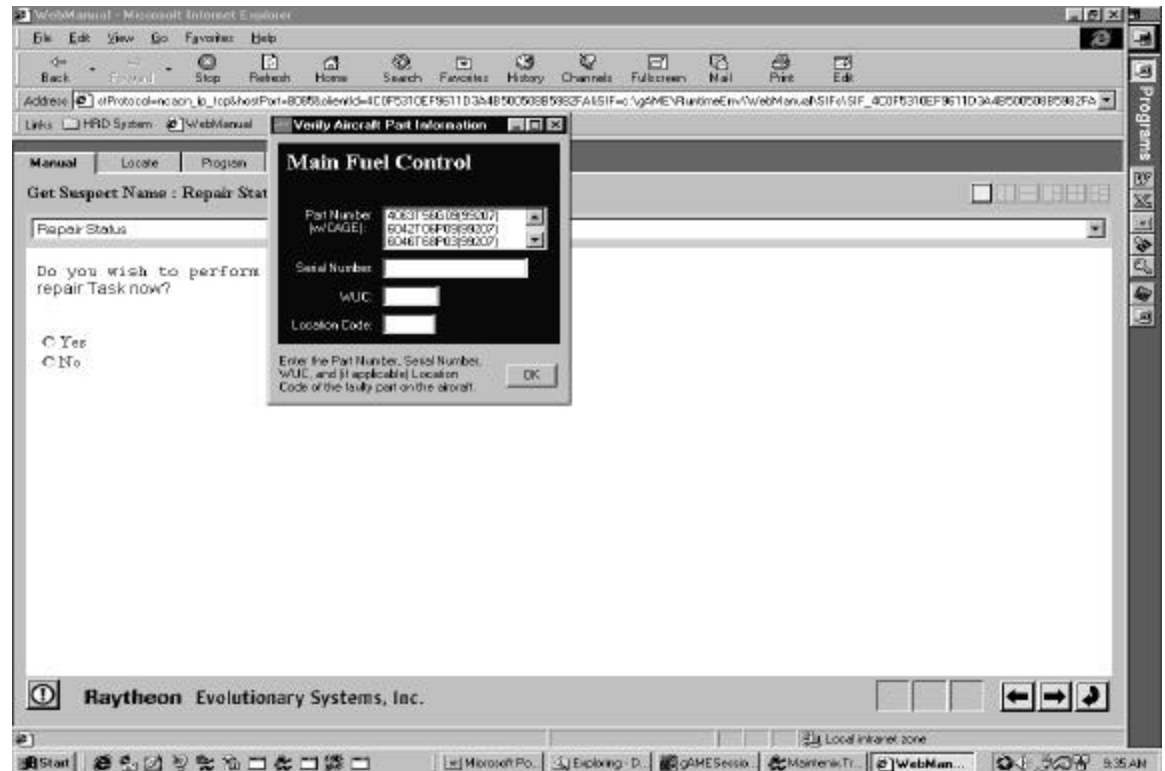
Execute Maintenance Tasks

The maintainer takes the PEDD out to the aircraft and uses the IETMs while executing the maintenance tasks



Upload the Maintenance Done from the PEDD

- The PEDD records serialized component changes
- The Session Manager is used to upload the maintenance done on the aircraft into Maintenix



I ETMS TPDR


- Create a bookmark in I ETMS when a problem is suspected
- Initiate HRD with the I ETMS bookmark to create a TPDR

Help Request Document System - Microsoft Internet Explorer

File Edit View Go Favorites Help

Address <http://skyhawk/hrdsystem/>

Help Request Document System

Click this icon  to edit this HRD.
 To **view the contents of a chat log, a text note, or an image** click on its title.
 To **sketch on an image**, click the edit icon next to the image title.

HRD	
Title	Incorrect Procedure Description
Author	tech
Created on	11 Sep 1998 18:32

Address	
From	NAVAVNDEPOT JACKSONVILLE
To	O-level aaa O-level ccc
Information	AIG FOUR TWO THREE

References	
Name	Design Part B

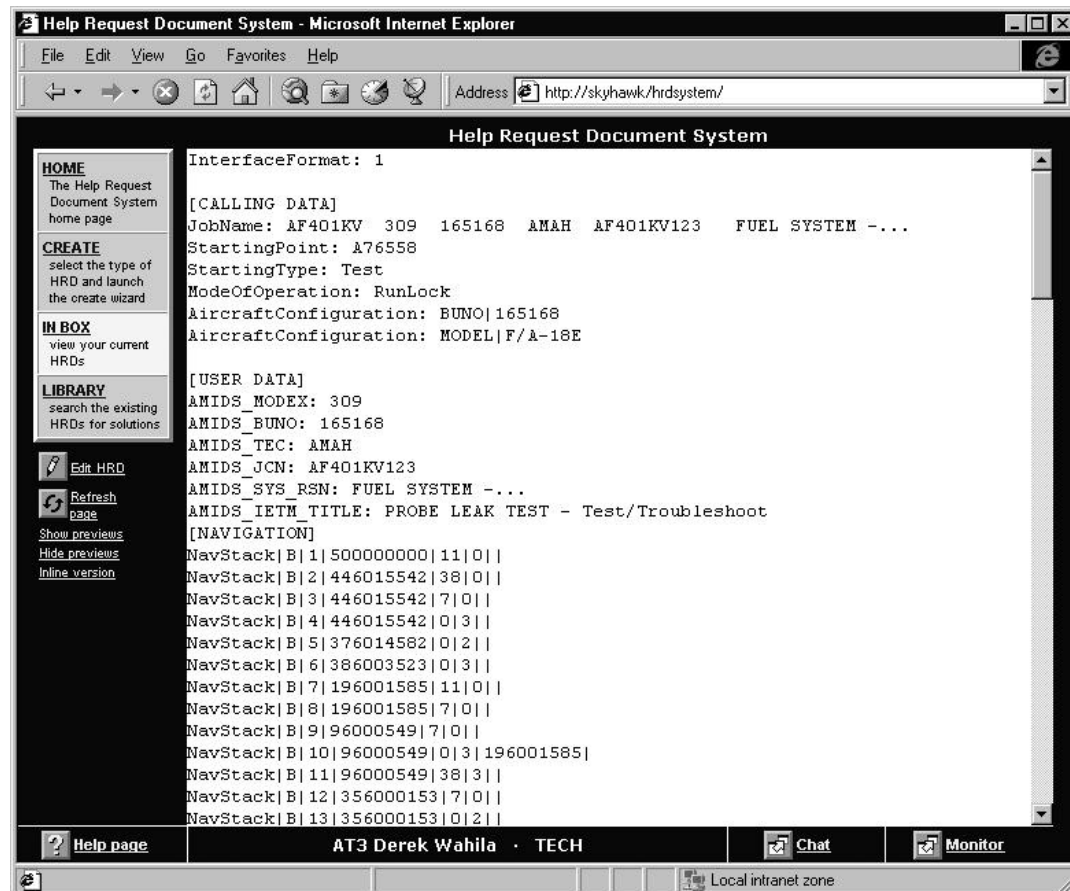
TPDR	
Report Control Number	TBD
Cognizant Field Activity	O-level aaa
Julian Date Discovered	06 Aug 1998 20:11
Location Discovered	NAVAVNDEPOT JACKSONVILLE

[? Help page](#) AT3 Derek Wahila · TECH [Chat](#) [Monitor](#)

Local intranet zone

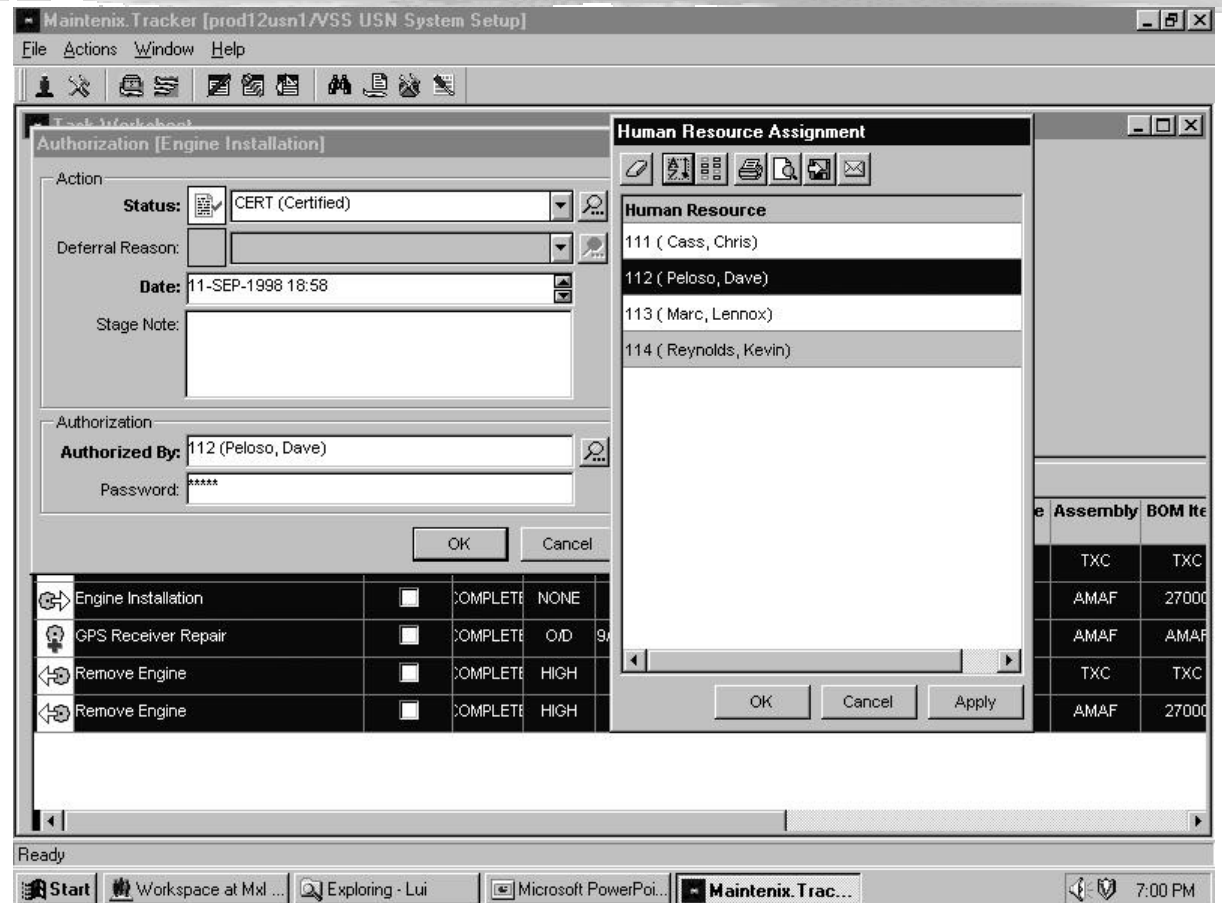
Evaluate the TPDR

- The TPDR is transferred to ISEA by the HRD system
- The TPDR is evaluated and used to update new releases of IETMS



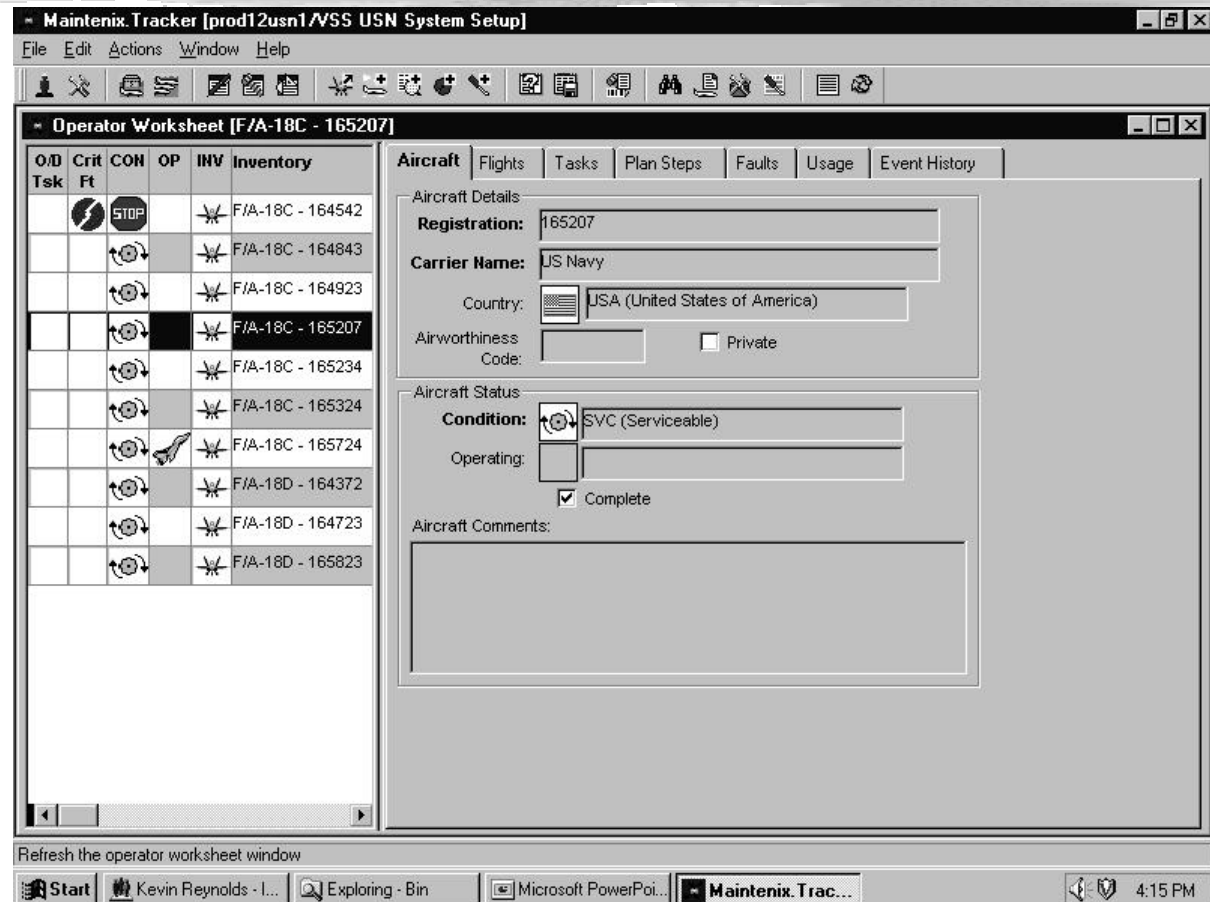
Complete the MAF and sign off the work in Maintenix

- The MAFs are completed in NALCOMIS
- Maintenance Control signs off the uploaded tasks in Maintenix



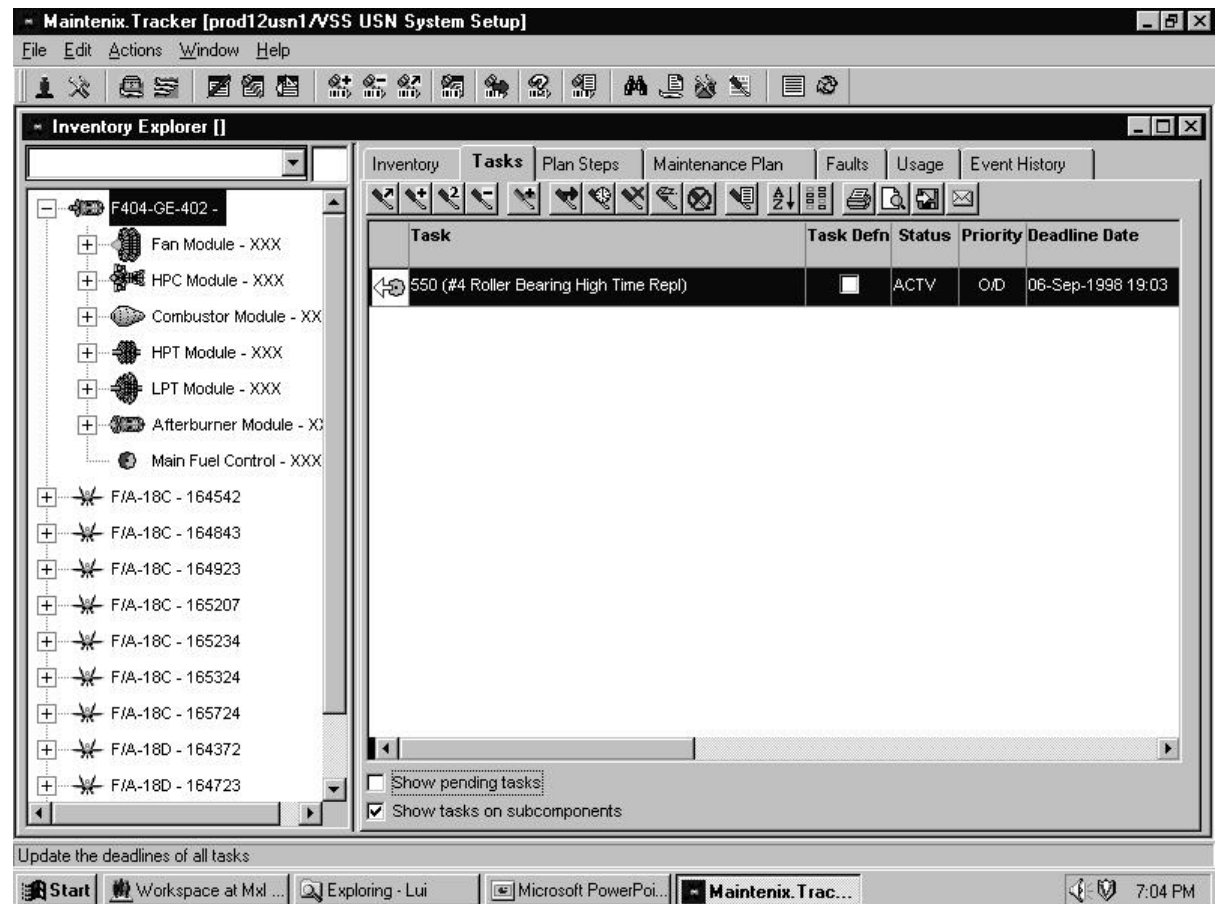
Aircraft Status is updated

- The PEDD upload installed the new engine in the aircraft logset
- The Status Board now shows the aircraft as ready to fly



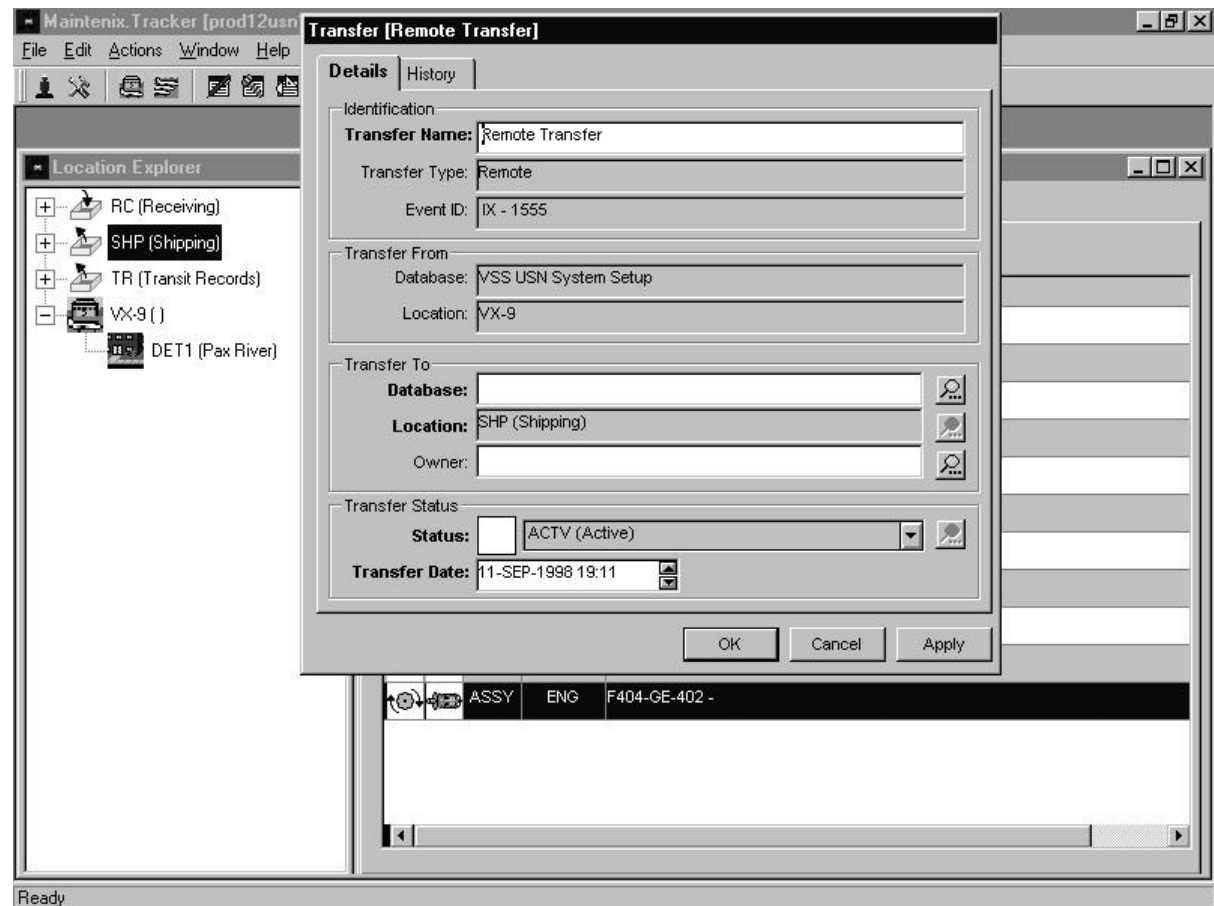
The Removed Engine's Logset is Intact

- The high-time engine is now out of the aircraft
- The engine logset is intact

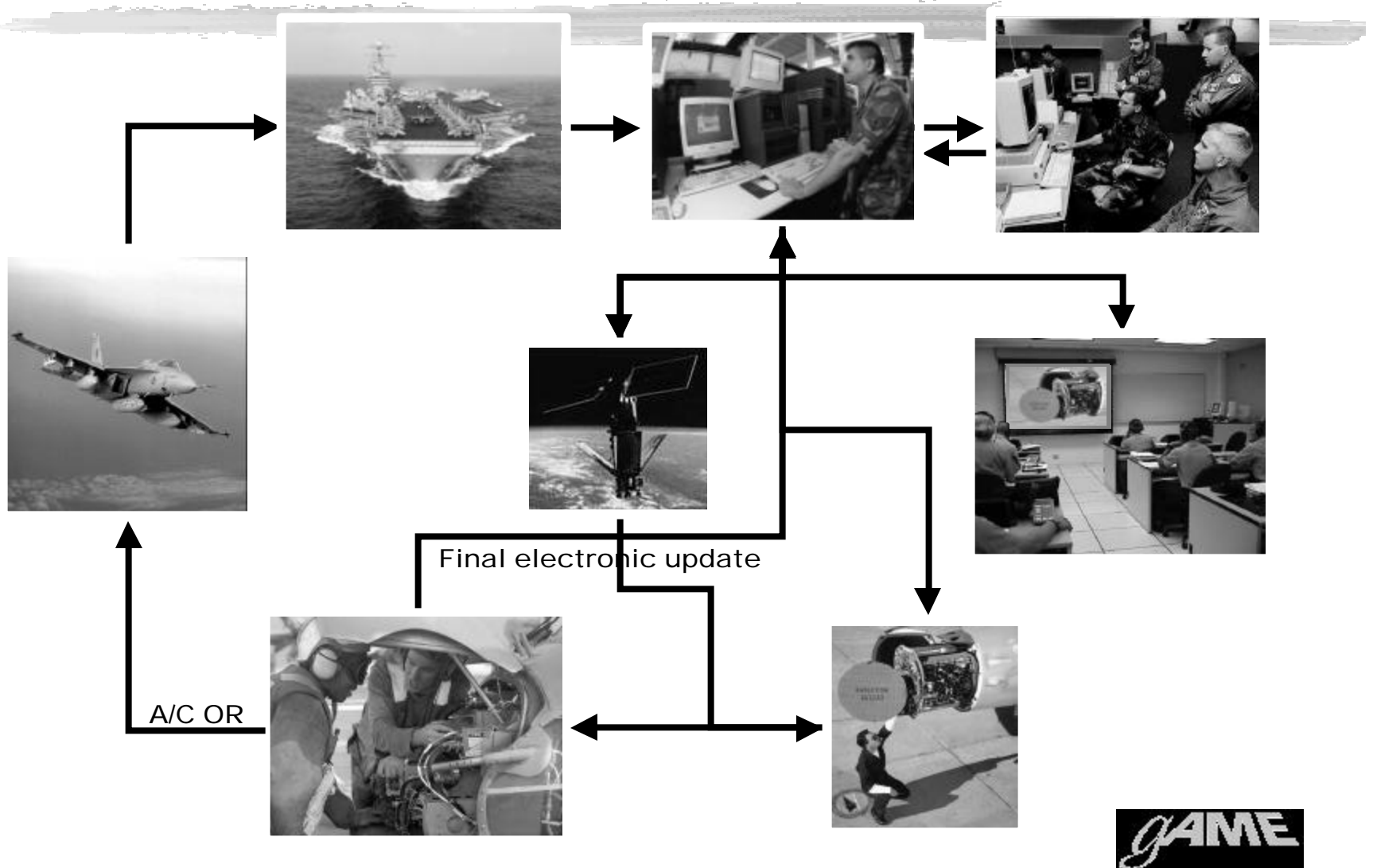


Transfer Engine Logset to IMA

- The engine (with the entire engine logset) is placed in the IMA inbox
- The transfer takes place automatically in the background



What's in the near Future?



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Additional Capabilities



Modify a Maintenance Plan

■ What Occurs:

- A new TD has been approved for the engine
- "*Fleet Management*" creates the electronic TD task **ONCE** as a baseline data modification
- This modification is broadcast automatically to affected sites.
- The TD appears as a "due" task in the aircraft's maintenance due list.

■ gAME Modules involved:

- Maintenix/OOMA



Define TD as a new Task

- TD is entered at central repository
- Define:
 - Applicability criteria
 - Tools required
 - Consumables required
 - Part and labor costs
 - Part Number Transformation

Task Definition [TD001 (Inspect Blade Set for Cracking)]

Task Details | Task Applicability | Scheduling Interval | Parts Consumable List | Tool List | Labour List | **Part Transformation** | Task Dependency

Old Part Name	Old Part No	Old Part Manufacturer	New Part Name
Stage 1 Fan Blade Set	5088T29P01	99207 (General Electric)	Stage 1 Fan Blade Set

Task Definition [TD001 (Inspect Blade Set for Cracking)]

Scheduling Interval | Parts Consumable List | Tool List | Labour List | Part Transformation | **Task Dependency**

Action	Task Definition	Status
CHG (Change Existing)	215 (Stg 1 Fan Blade Set High-Time Re	CANCEL (Cancelled)

OK Cancel Apply

TD Broadcast to Those Affected

- TD task automatically created against target aircraft
- TD task automatically appears in aircraft / engine maintenance due list
- TD record follows the engine so status of TD always known

Maintenix Tracker [prod12usn1/VSS USN System Setup]

File Actions Window Help

Task Worksheet

Retrieve: Row Limit: 1000

Search By:

Inventory: Root Inventory: Assembly: TXC(F404-GE-402) BOM:

Assigned To: Plan Step:

Task: Task Class: MOD (Modification) Status: PEND (Pending) ☐ Historical Tasks

Work: Labour Skill: Work Type: HR: Work Dept:

Task	Task Defn	Status	Priority	Deadline Date	Main Usage Until Deadline	Usage Until Deadline	Assembly	BOM Item
TD001 (Inspect Blade Set for Cracking)	<input checked="" type="checkbox"/>	PEND	NONE	11/10/98 19:18:36	60.0hour(EOT)	2.0month(CMON)	TXC	274121
TD001 (Inspect Blade Set for Cracking)	<input checked="" type="checkbox"/>	PEND	NONE	11/10/98 19:18:36	60.0hour(AFH)	2.0month(CMON)	TXC	274121
TD001 (Inspect Blade Set for Cracking)	<input checked="" type="checkbox"/>	PEND	NONE	11/10/98 19:18:36	60.0hour(AFH)	2.0month(CMON)	TXC	274121

3 Rows Retrieved

Start Kevin Reynolds - I... Exploring - temp Microsoft PowerPoint... Maintenix Trac... 7:21 PM

Offline Toolkit

- What Occurs:

- Engine performance trending analysis
- Engine flight summary

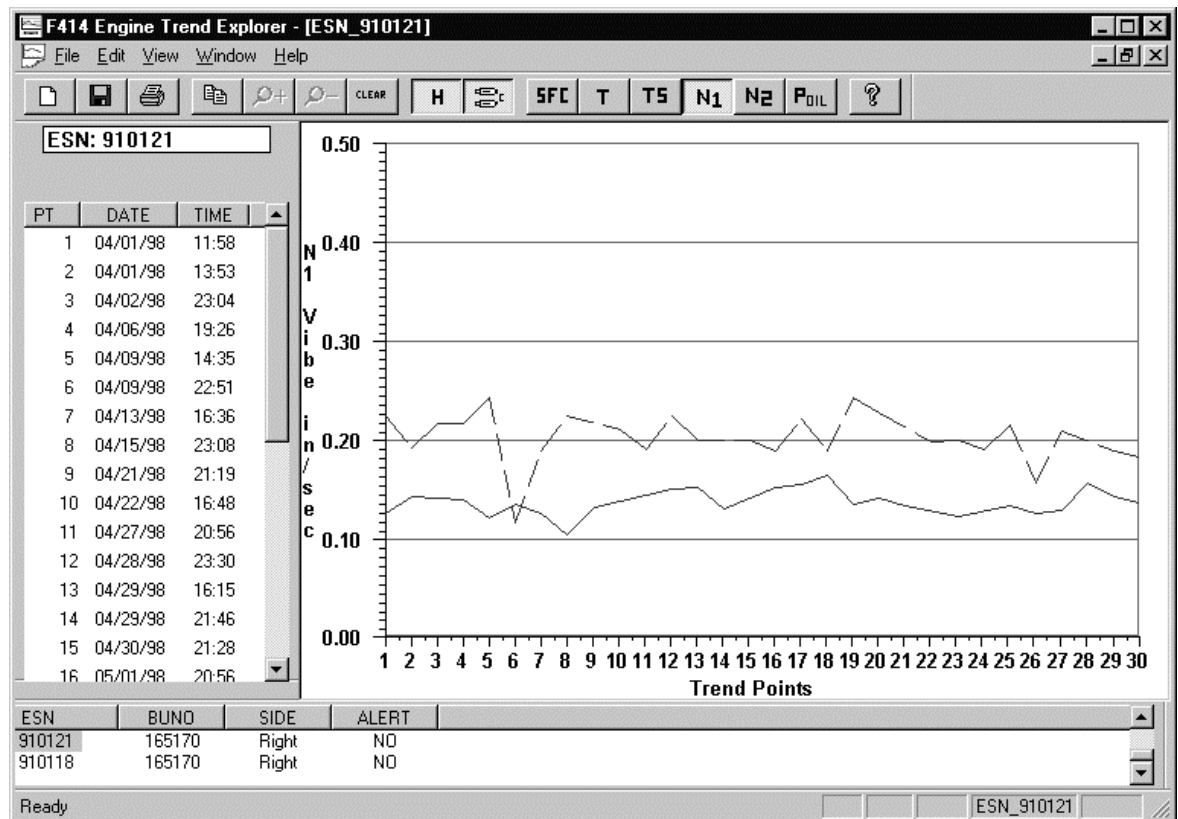
- gAME Modules involved:

- F414 Trend Explorer
- F414 Engine Flight Summary



Typical Engine Trending

- Scenario
 - View engine degradations over time
- Display Engine Trend parameters & inform maintainer of trend alerts:
 - Specific Fuel Cons'n, Thrust, Turbine Exit Temperature, Fan Vibe, Core Vibe, Turbine Exit Pressure, Oil Pressure



Typical Flight Summary

- Scenario
 - Relate pilot gripes to MU records
- Purpose
 - Provide a breadth-first view of engine data for a selected ADF
 - MSP Codes, Cautions, Pilot Saves, Thrust Checks, Mission Profile

Untitled - Engine Flight Summary

File Edit View Help

BUND: 165167 Type: Flight Date: 08-APR-98 Time: 16:25:04

☐ Left Engine Data ☒ Right Engine Data

ESN: 910114 Fadec Software: 11E-2A8 ESN: 910115 Fadec Software: 11E-2A8

Time	Description
18:16:55	Caution: FADEC Chnl Degrade
18:22:54	Caution: RATS Not Available
	No MSP codes
18:08:16	Pilot Data Save
	No Thrust Checks

Time	Description
17:57:29	Caution: Fuel Overtemperature
18:16:55	Caution: FADEC Chnl Degrade
18:22:54	Caution: RATS Not Available
17:57:29	0777 Fuel Overtemperature
17:57:35	06C4 Fuel Temp Sensor Fail
18:08:16	Pilot Data Save
	No Thrust Checks

For Help, press F1

Conclusion



- Raytheon has several years experience managing the technologies specific to an Enterprise Maintenance Management task.
 - This experience provides significant contribution to overall program risk reduction.
- To Raytheon, gAME is not a product set! It represents an integrated, open architecture, modular solution to maintenance management challenges.
 - Methodologies demonstrated in sAME

